Observed Variability in Rain from DPR and NPOL during OLYMPEx

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Overview

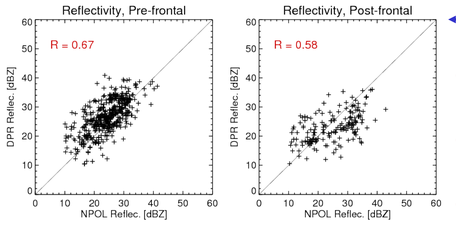
The precipitation regime over the Olympic Peninsula is difficult for retrievals of precipitation at all scales, from ground instruments to ground-based radars to satellite remote sensors. Additionally, the large weather systems affecting the region have variable and often low melting layers, leading to complex precipitation formation processes. The goal of this analysis is to better understand how well precipitation is captured from various sensors, including point-based disdrometers, polarimetric ground-based radars, and the GPM dual-frequency precipitation radar (DPR). We investigate possible sources of differences in rain rate estimates related to sampling differences, retrieval algorithms, and precipitation microphysics.

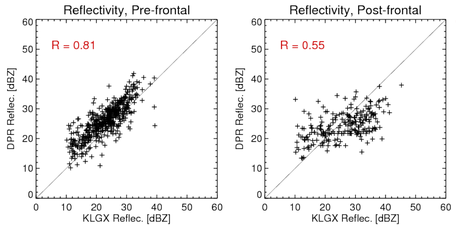
Methodology

- GPM – Ground Radar
  - Selected overpasses with precipitation within the DPR swath and NPOL / KLGX range
  - Limit to sector over the ocean to avoid complications from topography
  - Limit matched points to the rain region at the 0.5 km (40 km or 80 km range based on the melting layer height)
  - Classified overpasses into 'pre-frontal' and 'post-frontal' regimes
- NPOL – APU
  - Matched APU points to NPOL RHIs in time
  - Averaged 5 closest radar gates around APU point

GPM Overpass comparisons

Pre Frontal | Post Frontal





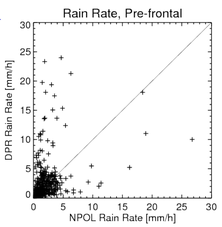
DPR <-> NPOL

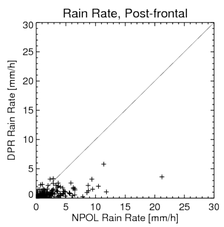
Key Points:

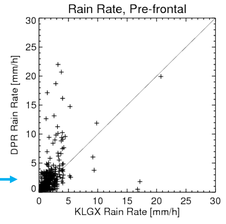
- NPOL –GPM Z_h correlations are relatively low
- KLGX – GPM Z_h correlations are higher for pre-frontal
- Generally pre-frontal Z_h correlations higher
- Compared to both KLGX and NPOL, GPM overestimates rain rates in prefrontal and underestimates in post-frontal

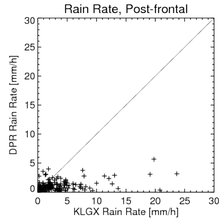
DPR <-> KLGX

Pre Frontal | Post Frontal



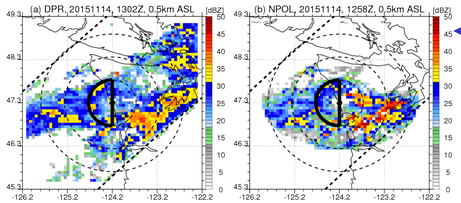


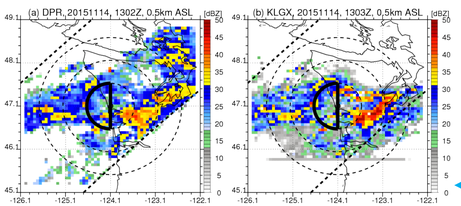




Timing

Pre Frontal | Post Frontal

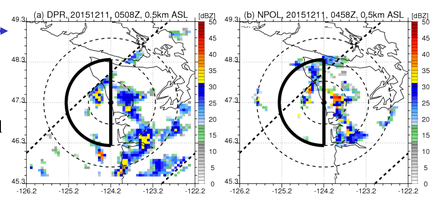


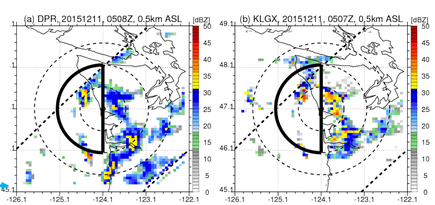


DPR <-> NPOL

- **Pre-Frontal**:
  - NPOL PPIs were ~7-10 min from GPM overpass
  - Echoes advect by several pixels over this time
  - KLGX were < 3 min
  - -> Higher KLGX Z_h correlations
- **Post-Frontal**:
  - Faster storm lifecycle influences both radar correlations
  - Slope of scatter plot indicates more systematic problem?

DPR <-> KLGX



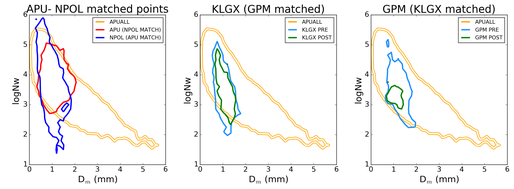


Drop Size Distribution – D_m and N_w

- Original N_w and D_m comparisons between NPOL and APUs and NPOL and GPM showed low bias on NPOL N_w calculation
- APU data used to derive new relationships:

$$D_m = 0.72+0.829Z_{dr}+0.189Z_{dr}^2-0.0738Z_{dr}^3$$

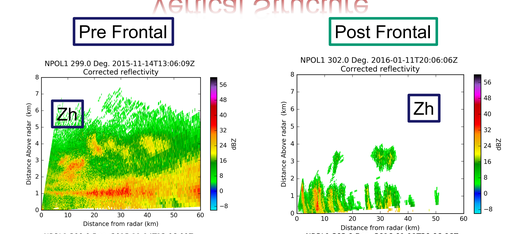
$$N_w = 27.345Z^{0.998}D_m^{-7.192}$$

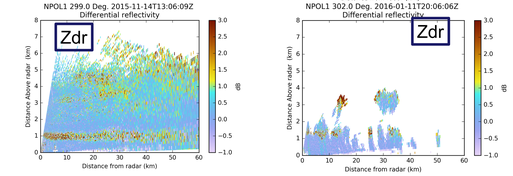


- Compared to matched APU points, NPOL stretched to high and low N_w (Z_{dr} lower limit?)
- GPM N_w-D_m is generally within the range illustrated by the APU
- KLGX and GPM have similar ranges during pre frontal cases
- GPM has very narrow range of values in post-frontal

Vertical Structure

Pre Frontal | Post Frontal





- Deep ice region with lots of variability
- Clear bright band

- Virtually no ice aloft; shallow echoes
- Tilted echoes toward the surface

Acknowledgements

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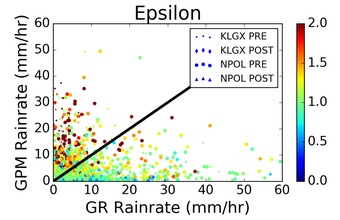
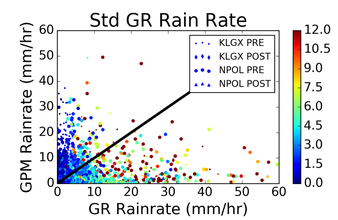
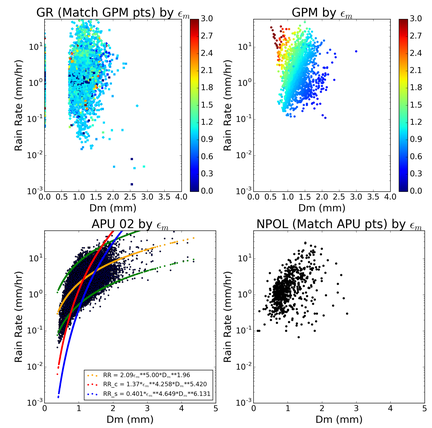
Variability in RR and ε assumption





- Points that deviate significantly from the 1:1 line are associated with ε values away from 1, where large ε values are associated with GPM points that overestimate the rain compared to GR (typical of pre-frontal)
- Points where GPM underestimates RR compared to NPOL are associated with times where the sdev(RR) within a GPM footprint is high (>5 mm /hr)
- These points generally occur in post-frontal situations, where echoes are small and scattered



- High rain rates for a given D_m for $\varepsilon > 1$
- No such trend obvious in the NPOL or ground observations
- Need to revisit the R-D_m relationship that is used by GPM (red/blue lines)?

Findings

- Timing of overpass comparisons is important
  - Lower NPOL Z_h correlations due to longer time differences with GPM
- Structure of echoes also plays a role in the Z_h correlations and DSD
  - Prefrontal have deep ice aloft, while post frontal has little ice and echoes slant near the surface
- Specific N_w and D_m relationships to polarimetric measurements were derived for OLYMPEx from the APUs to be applied to ground radars
- Generally DSD parameters from all three measurements are similar
  - However, NPOL has long N_w tails possibly due to Z_{dr} limits?
  - GPM post-frontal is very constrained in N_w comparatively
- Lots of subfootprint variability in rain rate generally associated with points where GPM underestimates compared to ground radar
- Large ε values associated with points where GPM rain rates were larger than ground radar